**Retinotopic and orientation specificity of healthy human EEG power**

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**Abstract**: The healthy human EEG signal exhibits a rich spectral content spanning frequencies from 0-100Hz. However, differences in basic tuning properties such as retinotopic or orientation selectivity of these different bands remain largely unexamined, despite potential to provide valuable information on the neural specificity of each band. To address this, we examined the frequency specific EEG response to two separate stimuli 1) a rotating wedge designed to control retinotopically specific activation and 2) a rotating grating designed to control orientation specific activation. We find that while alpha, beta, and gamma frequencies all have similar responses to the rotating wedge, the higher frequencies (gamma, 30Hz+) are more sensitive to orientation. Furthermore, we find gamma orientation tuning in two narrow-band channels a) low (30Hz) and b) high (60Hz) gamma bands. Power in these two bands is highly tuned to orientation, preferring obliquely oriented gratings. These results suggest that functionally specific information is fed forward in distinct frequency channels of the gamma range, while alpha/beta serves as more of a background suppression rhythm. These results provide the first neurophysiological evidence supporting low spatial frequency predominance of oblique orientation in human BOLD signal. They also suggest that feedback may not be functionally specific as feed-forward activity.

**Introduction:** Brain oscillations exist across a wide frequency spectrum, spanning 0-100Hz in non-invasive recordings (refs), and much higher in invasive preparations (refs). Embedded in this broadband signal however are characteristic peaks, which are thought to be due to different neuronal processes. Indeed, within the healthy human EEG signal there are in particular two bands of interest the alpha/beta (8-25Hz) and the gamma (30+Hz) bands, which have come under intense scrutiny due to their strong responsiveness to a number of stimulus conditions (refs). This strong interest has generated several hypotheses about the functional nature of these two bands, and more recently, it has been proposed that in the visual cortex these bands index the direction of information flow in the brain, with gamma associated to feed-forward processing from cortical input layers to higher visual areas, and alpha/beta associated with feedback connections from those higher areas (Refs).

While elaborate experimental (ref) and analytical (ref) approaches have been carried out to determine the frequency specific nature of feed-forward and feedback connections in the brain, another approach to investigate the issue would be to test the functional specificity of each band. Typically, alpha/beta responds to a stimulus with decreases in narrow band (8-25Hz) power, or suppression of an ongoing oscillation. The gamma band responds much differently, with increases anywhere from 30-100+Hz, which can be broadband (ref), narrow-band (ref), or narrow-band in different frequency ranges (ref, Lima). Hypotheses on the role of these two bands would necessarily predict their functional responsiveness. If gamma is a measure of feedforward neuronal processing, it should be specific to both retinotopic location of a stimulus, and orientation of a stimulus, two key functional properties of human visual cortex (ref, Hubel). If alpha/beta indexes feedback processing from higher visual areas it should index retinotopic location, and possibly orientation (ref) while others argue that orientation is not dependent on feedback (ref).